THE EFFECT OF SELECTED NUTRIENTS ON REPRODUCTIVE PHYSIOLOGY OF SCALED AND BOBWHITE QUAIL: PHASE III—PROTEIN REQUIREMENTS FOR GROWTH OF YOUNG SCALED QUAIL

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FINAL PROGRESS REPORT

The ability to determine the age of young-of-the-year and especially the age distributions within this group is important to any study concerned with breeding season phenology or hatch chronology in wild populations of game birds. Dwight (1900) observed the incomplete post-juvenal molt in quail and grouse; Leopold (1939) clearly outlined use of this characteristic to segregate individuals into juvenile, immature and adult age classes. Bureau (1911, 1913) reported that juvenal primary feather replacement and growth could be used to accurately determine, within 1 to 3 days, the age of Hungarian partridge (Perdix perdix) and red partridge (Alectoris rufa) in the juvenile age class. In North America, measurement of the growing primaries is a method commonly used for age determination of young quail.

Limited data has been published on growth in the juvenile scaled quail (Callipepla squamata), an important gamebird in Texas, Oklahoma, New Mexico, Arizona, Colorado and Mexico. Discrepancies between aging criteria published by Wallmo (1956), Ohmart (1967) and age estimation of retrapped wild scaled quail juveniles in Texas encouraged this lab to report more extensive data in juvenal primary replacement and growth in this species (Smith and Cain, 1982). The suitability of using other growth characteristics as aging criteria was also investigated and generally these were more variable than feather growth.

The variability of various growth rate parameters of scaled quail reared under constant dietary and environmental conditions, and the discrepancies between rates of feather growth reported by various workers lead us to speculate that the content of their diet would influence growth rates and thus account for some yearly variations. Normal dietary consumption by young quail includes large percentages of insects and growing parts of forbs, both high protein content items. These are in abundance during average and above normal rainfall years and less plentiful in dry years. In the absence of quantitative dietary information during dry years, we decided to look at viability and growth rate of scaled quail chicks fed diets containing low, medium and high crude protein percentages.

Growth rate, viability and post-juvenal feather molt were measured biweekly for 368 scaled quail fed isocaloric diets containing 12, 16, 20, 24, 26, 28, 30 or 32% crude protein (cp) from hatch to 20 weeks of age. The quail were randomly divided into 3 replicates and housed in battery brooders for the first 4 weeks, thereafter in colony cages in a controlled environment room. Growth rate was assessed by measuring body weight, lengths of tarsometatarsus, tibiotarsus and primary feathers. Analysis by ANOVA indicated significant diet and sex but not replicate effects.

Diets containing less than 26% cp reduced growth rates and delayed post-juvenal molt of young quail. After 6 weeks of age, compensatory growth occurred for chicks fed 24% cp diets. Body weights of 16 and 20% cp groups were normal by 20 and 22 weeks respectively, but 12% cp birds remained stunted (Table 1). Long bone growth was temporarily reduced in 20 and 24% cp groups and 12 and 16% cp diet groups were permanently stunted (Table 2). Post-juvenal molt was significantly retarded in 12, 16 and 20% cp groups at 6 weeks of age and persisted in 12 and 16% cp groups to 12 weeks of age (Table 3).

Mature length of primary feathers 1, 2 and 3 was reduced by 8-11% in birds on 12, 16 and 20% cp diets (Table 4). Primaries 4-10 grew significantly slower in 12 and 16% cp groups and mature lengths were 3 to 4% shorter than higher cp fed quail. Viability was low in the 12, 16 and 20% cp groups averaging 27, 35 and 33% respectively (Table 5). Significant male-female growth rate differences of 5 to 10% were noted from 4 to 20 weeks of age for body weight and tarsometatarsus and tibiotarsus length.

The results of this experiment have several implications for wild populations of scaled quail and any management efforts directed toward their behalf. First, it is obvious that dietary composition influences growth rate, a fact not previously considered when aging quail using primary feather growth tables. Since hatching dates are calculated by aging trapped quail, the accuracy of this technique probably varies considerably with food quality variations from year to year. Thus, studies relating reproduction with critical environmental events may come to erroneous conclusions. Secondly, it was apparent that viability was significantly by dietary quality. This may have implications for management through supplemental feeding in years when reproductive successes are low and livability of those that hatch is at a premium. Finally, this is the first documentation of the rather large sexually dimorphic differences in scaled quail anatomy.

TABLE 1. Mean Body Weight By Age of Scaled Quail Fed Various Protein Diets

DIETS	AGE IN WEEKS											
	2	4	6	8	10	12	14	16	18	20	22	24
12	14.1^{D}	22.5^{E}	34.2^{D}	63.0^{E}	87.6^{E}	109.7^{C}	122.0^{D}	137.7^{D}	147.8^{D}	151.4^{D}	157.5^{B}	161.3^{B}
16	15.9^{D}	32.8^{D}	62.3^{C}	94.8^{D}	122.5^{D}	138.6^{B}	150.6^{C}	150.3^{C}	158.9^{C}	163.7^{C}	167.5^{A}	170.0^{A}
20	20.0^{C}	40.0^{C}	66.2^{C}	105.9^{C}	135.6^{C}	152.0^{A}	159.6^{B}	159.6^{B}	161.6^{CB}	167.5^{CB}	174.0^{A}	
24	22.7^{B}	49.7^{B}	84.4^{AB}	119.3^{B}	141.7^{BC}	151.2^{A}	161.5^{AB}	164.7^{AB}	169.3^{AB}	173.9^{AB}		
26	24.7^{A}	50.3^{AB}	84.3^{B}	123.1^{AB}	146.1^{AB}	152.9^{A}	162.3^{AB}	167.4^{A}	173.5^{A}	176.9^{A}		
28	23.3^{AB}	51.3^{AB}	88.3^{AB}	123.8^{AB}	148.8^{AB}	157.9^{A}	166.8^{AB}	167.6^{A}	170.4^{A}	175.3^{AB}		
30	22.4^{B}	48.9^{B}	88.4^{AB}	125.5^{AB}	150.7^{A}	157.8^{A}	166.2^{AB}	169.6^{A}	174.1^{A}	177.8^{A}		
32	24.9^{A}	54.6^{A}	92.4^{A}	129.7^{A}	152.9^{A}	111.9^{C}	168.1^{A}	169.7^{A}	174.0^{A}	171.8^{AB}		

TABLE 2. Mean Tibiotarsal Length By Age of Quail Fed Various Protein Diets

DIETS	AGE IN WEEKS 2	4	6	8	10	12	14	16	18	20	22	24
12	26.7^{E}	32.2^{D}	37.3^{E}	45.5^{E}	51.5^{D}	54.0^{E}	55.0^{C}	54.8^{D}	55.0^{C}	56.8^{C}	55.5^{B}	56.2^{A}
16	28.3^{D}	35.3^{C}	44.9^{D}	53.2^{D}	57.0^{C}	57.4^{D}	57.3^{B}	56.9^{C}	57.1^{B}	57.4^{C}	57.2^{A}	
20	29.4^{C}	38.3^{B}	47.2^{C}	55.2^{C}	58.2^{BC}	58.6^{C}	58.3^{AB}	58.4^{B}	58.0^{AB}	58.8^{B}	58.5^{A}	
24	30.4^{AB}	40.6^{A}	50.3^{B}	57.1^{B}	59.0^{AB}	59.1^{BC}	58.8^{A}	58.8^{B}	59.0^{A}	60.4^{A}		
26	30.8^{AB}	41.1^{A}	50.0^{B}	57.4^{B}	59.2^{AB}	59.1^{BC}	58.5^{A}	58.5^{B}				
28	31.0^{AB}	41.2^{A}	50.5^{B}	57.9^{AB}	59.2^{AB}	59.4^{ABC}	58.8^{A}	58.0^{BC}				
30	30.3^{B}	41.0^{A}	51.4^{AB}	58.1^{AB}	59.6^{A}	60.3^{A}	59.5^{A}	60.8^{A}				
32	31.2^{A}	41.5^{A}	53.0^{A}	58.9^{A}	59.6^{A}	59.9^{AB}	58.7^{A}	59.1^{B}				

TABLE 3. Percentage of Quail By Age Initiating Growth of First-Winter Primary Feathers Fed Various Protein Diets

	P_9	P_{10}	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8
AGE 4										
12	.95	.05	0	0						
16	1.00	.39	.32	.07						
20	1.00	.80	.51	.13						
24	1.00	1.00	.93	.07						
26	1.00	1.00	.78	.20						
28	1.00	.91	.84	.29						
30	1.00	1.00	1.00	.63						
32	1.00	1.00	.97	.18						
AGE 6										
12	1.00	1.00	.74	.47	.08	0				
16	1.00	1.00	1.00	.95	.84	.19				
20	1.00	1.00	1.00	1.00	.71	.29				
24	1.00	1.00	1.00	1.00	.96	.71				
26	1.00	1.00	1.00	1.00	.90	.61				
28	1.00	1.00	1.00	1.00	1.00	.48				
30	1.00	1.00	1.00	1.00	1.00	.64				
32	1.00	1.00	1.00	1.00	1.00	.45				
AGE 8										
12					1.00	1.00	.17	0		
16					1.00	1.00	.88	.10		
20					1.00	.94	.76	.14		
24					1.00	1.00	1.00	.47		
26					1.00	1.00	.89	.52		
28					1.00	1.00	1.00	.36		
30					1.00	1.00	1.00	.52		
32					1.00	1.00	1.00	.41		
AGE 10										
12							.77	.38	0	
16							1.00	.94	.30	
20							1.00	1.00	.38	
24							1.00	1.00	.74	
26							1.00	1.00	.39	
28							1.00	1.00	.62	
30							1.00	1.00	.67	
32							1.00	1.00	.56	
AGE 12										
12							1.00	1.00	.75	0
16							1.00	1.00	.87	.11
20							1.00	1.00	1.00	.38
24							1.00	.84	1.00	.32
26							1.00	1.00	1.00	.59
28							1.00	1.00	1.00	.45
30							1.00	1.00	1.00	.50
32							1.00	.96	1.00	.33
AGE 14										
12									1.00	.50
16									1.00	.94
20									1.00	.88
24									1.00	.88
26									1.00	.97
28									1.00	.97
30									1.00	1.00
32									1.00	.79

TABLE 4. Mean Length of Primary Feather 2 By Age of Quail Fed Various Protein Diets

	AGE IN WEEKS											
DIETS	2	4	6	8	10	12	14	16	18	20	22	24
12			15.3^{D}	51.9^{D}	71.4^{D}	73.1^{C}	72.2^{D}	71.7^{E}	73.0^{B}			
16			36.7^{C}	72.2^{CB}	75.3^{C}	76.9^{B}	76.7^{C}	76.1^{DC}	76.0^{A}			
20		0.0^{B}	37.0^{C}	70.4^{C}	75.7^{CB}	76.9^{B}	76.5^{C}	74.9^{D}	75.0^{AB}			
24		5.0^{AB}	47.5^{AB}	75.2^{AB}	77.4^{AB}	77.8^{AB}	78.0^{ABC}	78.0^{ABC}	78.0^{A}			
26		0.0^{B}	45.5^{B}	75.4^{AB}	77.0^{AB}	77.1^{B}	77.5^{BC}	77.8^{BC}	77.8^{A}			
28		8.8^{A}	47.5^{AB}	75.8^{AB}	77.6^{A}	78.6^{A}	78.8^{AB}	77.6^{BC}	78.0^{A}			
30		2.7^{B}	53.9^{A}	76.3^{AB}	77.4^{AB}	78.3^{AB}	77.9^{ABC}	78.6^{AB}	78.4^{A}			
32		2.2^{B}	50.2^{AB}	76.5^{A}	78.0^{A}	78.8^{A}	79.0^{A}	79.7^{A}	79.2^{A}			

TABLE 5. Viability By Age of Scaled Quail Groups Fed Various Protein Diets

		AGE IN WEEKS											
DIETS	HATCH	1	2	3	4	6	8	10	12	14	16	18	20
12	1.00	.69	.52	.43	.44	.42	.27	.27	.27	.27	.27	.27	.27
16	1.00	.77	.70	.69	.61	.48	.37	.37	.35	.35	.35	.35	.35
20	1.00	.80	.80	.77	.76	.47	.40	.40	.38	.38	.33	.33	.33
24	1.00	.80	.71	.71	.67	.62	.62	.60	.58	.58	.51	.51	.49
26	1.00	.77	.71	.71	.71	.67	.67	.64	.64	.64	.62	.62	.62
28	1.00	.78	.78	.71	.71	.64	.60	.67	.64	.64	.62	.62	.62
30	1.00	.83	.82	.77	.69	.64	.62	.60	.60	.60	.60	.60	.60
32	1.00	.86	.80	.80	.76	.64	.64	.64	.64	.64	.62	.62	.62